

### **REMARKS**

Claims 4-14 and 17-23 are rejected under 35 USC §103. The applicants respectfully traverse these rejections and request reconsideration of the application in view of the above amendments and the following remarks.

Claim 4 has been amended, Claim 22 has been canceled and Claims 24-27 have been added. None of the changes constitute new matter since this clarification of the claims is supported by the original disclosure.

### **REJECTIONS UNDER 35 USC §103**

Claims 4-14 and 17-23 were rejected under 35 USC 103(a) as being unpatentable over U.S. Patent no. 6,066,714, hereinafter referred to as "Putzig", in view of U.S. Patent no. 5,017,680, hereinafter referred to as "Sublett", and U.S. Patent no. 5,610,231, hereinafter referred to as "Braune". Specifically, the Office Action suggests Putzig discloses a process for the esterification of a dicarboxylic acid compound with a catalyst comprising an organic titanium compound of two or more of a general formula  $[Ti(OR)_4]_n$  with n being 2 or more; Sublett disclose a complex catalyst of titanium/alkali metal or alkaline earth metal, such as titanium glycolate with an alkali or alkali earth metal salt, such as sodium glycoxide with a mole ratio of the alkali metal/titanium of 0.25/1 (equivalent to a mole ratio of 4:1 of titanium/alkali metal); and Braune suggests that in the preparation of thermoplastic polyesters alkali metal salts useful for esterification include sodium glycolate.

The examiner argues that Putzig discloses an organic titanium compound  $[Ti(OR)_4]_n$  where n is 2 or more (col. 2, lines 15-48). The citation is reproduced below:

According to the first embodiment of the present invention, a catalyst composition is provided. The composition can comprise an organic titanium compound, a phosphorus compound, an amine, and optionally a cocatalyst. The composition can also consist essentially or consist of an organic titanium compound, a phosphorus compound, an amine, and a cocatalyst.

The catalyst composition of this invention is substantially soluble in a solvent. The term "substantially" means more than trivial. It is preferred that the composition be completely soluble in the solvent. However, a substantial portion of the composition can also be suspended or dispersed in the solvent. According to the present invention the presently preferred titanium compounds are organic titanium compounds. Titanium tetrahydrocarbyloxides are presently the most preferred organic titanium compounds because they are readily available and effective. Examples of suitable titanium tetrahydrocarbyloxide compounds include those expressed by the general formula  $Ti(OR)_4$  where each R is individually selected from an alkyl, cycloalkyl, aralkyl, hydrocarbyl radical containing from 1 to about 30, preferably 2 to about 18, and most preferably 2 to 12 carbon atoms per radical and each R can be the same or different. Titanium tetrahydrocarbyloxides in which the hydrocarbyl group contains from 2 to about 12 carbon atoms per radical which is a linear or branched alkyl radical are most preferred because they are relatively inexpensive, more readily available, and effective in forming the solution.

Suitable titanium tetrahydrocarbyloxides include, but are not limited to, titanium tetraethoxide, titanium propoxide, titanium isopropoxide, titanium tetra-n-butoxide, titanium tetrahexoxide, titanium tetra 2-ethylhexoxide, titanium tetraoctoxide, and combinations of any two or more thereof.

A close reading of the citation does not support the examiner's interpretation. Polymeric titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_n]_n$  wherein n is 2 or more is not disclosed. A suitable example of a titanium tetrahydrocarbyloxide compound is given by "the general formula  $\text{Ti}(\text{OR})_4$  where each R is individually selected from an alkyl, cycloalkyl, aralkyl, hydrocarbyl radical containing from 1 to about 30, preferably 2 to about 18, and most preferably 2 to 12 carbon atoms per radical and each R can be the same or different" (col. 2, lines 33-38). This compound is not shown to be polymeric. Specific examples of titanium tetrahydrocarbyloxides are given as "titanium tetraethoxide, titanium propoxide, titanium isopropoxide, titanium tetra-n-butoxide, titanium tetrahexoxide, titanium tetra 2-ethylhexoxide, titanium tetraoctoxide, and **combinations of any two or more thereof** (col. 2, lines 43-43, emphasis added). There is no disclosure of titanium tetrahydrocarbyloxides as polymeric but as "combinations of any two or more compounds". Combining two or more of titanium tetraethoxide, titanium propoxide, titanium isopropoxide, titanium tetra-n-butoxide, titanium tetrahexoxide, titanium tetra 2-ethylhexoxide and/or titanium tetraoctoxide does not make them polymeric. There is no disclosure, teaching or suggestion in the citation by the examiner of  $[\text{TiO}_4(\text{CH}_2)_n]_n$  wherein n is 2 or more.

Putzig does disclose “[a]ny solvent that can substantially dissolve the catalyst composition disclosed above can be used in the present invention.” (col. 3, line 64-66) Putzig also discloses “[t]he presently preferred solvent is ethylene glycol for the polyester produced therefrom has a wide range of industrial applications.” (col. 4, lines 17-19) Putzig also discloses “[t]he catalyst composition can be produced in a solvent that is compatible with or does not interfere with an esterification or transesterification or polycondensation reaction. For example, if the catalyst composition is used as a polycondensation catalyst for producing PET, the composition is preferably produced in ethylene glycol” (col. 5, lines 3-8). The polymeric titanium glycolate catalyst of the claimed invention is not soluble in ethylene glycol but can be dissolved by alkali metal glycolate (page 5, lines 17-18). The polymeric titanium glycolate catalyst of the claimed invention is not the disclosed catalyst of Putzig.

The examiner argues that Sublett discloses a complex of a titanium/alkali metal or alkaline earth metal, such as titanium glycolate with sodium glycooxide. The titanium/alkali metal or alkaline earth metal complex of Sublett can be prepared in several ways:

**The titanium tetraisopropoxide (or other titanium alkoxides) is dissolved in ethylene glycol** and the metal salt (Na, K, Li, Mg, etc.) is dissolved in ethylene glycol. The metal salt solution is then added to the titanium alkoxide solution to obtain the desired metal/titanium ratio which has been formed by experimentation to 0.25/1 or greater. The solution is stirred at room temperature. The metal/titanium complex is also prepared by adding **ethylene glycol solutions of the titanium alkoxide** and ethylene glycol

solution of the soluble metal salt to the polyester reaction mix and stirring at room temperature.

(col. 7, lines 15-27, emphasis added)

The titanium alkoxides, which included titanium glycolate (col. 5, lines 12-14), are soluble in ethylene glycol. As noted above, the polymeric titanium glycolate catalyst of the claimed invention is not soluble in ethylene glycol. The polymeric titanium glycolate catalyst of the claimed invention is not the disclosed catalyst of Sublett.

Claims 24 and 25 have been added. Claim 24 reads in part “wherein the polymeric titanium glycolate is not soluble in ethylene glycol”. Support for this language is found on page 5, lines 17-19 and in Example 1, 1.1 Synthesis of titanium glycolate, where from a clear solution of titanium butylate and ethylene glycol a white solid precipitates. Claim 25 reads in part “wherein the polymeric titanium glycolate is soluble in an alkali metal glycolate”. Support for this language is found on page 5, lines 17-19, and in Example 1, 1.3 Synthesis of Ti/Na-glycolate complex where a suspension of polymeric titanium glycolate, sodium glycolate and ethylene glycol changes to a clear solution.

The examiner admits that Sublett does not disclose alkali metal glycolate but relies upon Braune for disclosure of sodium glycolate. However, Braune does not disclose a titanium-based catalyst. The alkali metal or alkaline earth metal compound is added during the esterification or transesterification portion of an esterification/polycondensation or transesterification/polycondensation process (col. 2, lines 59-66) as improvement over adding an alkali metal compound in polycondensation (col.1, lines 20-23; Claim 1). There is no disclosure, teaching or suggestion that the

alkali metal or alkaline earth metal compound acts as a catalyst or as a solvent for a catalyst or that it forms a catalyst complex with a titanium compound. It would not have been obvious for a person of ordinary skill in the art to substitute alkaline glycolate in the complex of titanium alkoxides and alkali or alkaline earth metal salt of Sublett as a catalyst for esterification.

The claimed invention is for an esterification process. Putzig discloses both esterification and transesterification (col. 1, lines 9-12). The examiner state that Sublett teaches esterification with a catalyst complex of titanium (Office Action of August 18, 2009, page 3, paragraph 3). Sublett discloses a process and catalyst-inhibitor system for preparing synthetic linear polyester and copolyester from dimethyl terephthalate and ethylene glycol (col. 1, lines 7-10) and is related to a specific catalyst system for poly(ethylene terephthalate) and copolyesters of poly(ethylene terephthalate) produced from dimethyl terephthalate (col. 2, lines 7-10), an ester exchange or transesterification process (col. 1, lines 28-30; col. 1, lines 41-43; col. 3, line 62. to col. 4, line 7; col. 4, lines 12-15). An esterification process is not disclosed in Sublett.

The examiner argues that one of ordinary skill in the art would combine Putzig and Sublett because they have the same objective and cites case law to support the rationale to modify or combine prior art not being expressly stated in the prior art but being implied from the prior art, general knowledge, established scientific principles or legal precedent. The examiner also cited case law that the examiner must present "a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references. Ex parte Clapp, 227 USPQ 972 (Bd. Pat App. & Inter. 1985). Additional case law supports this

requirement. There must be an explanation of the “common knowledge and common sense” which is relied upon. [Dystar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co. 464 F.3d 1356, 80 USPQ2d 1641, 1649 (2006)]. There must be some rationale, articulation or reasoned basis to explain why the conclusion of obviousness is correct. [Alza Corp. v. Mylan Labs., 464 F.3d 1286, 80 USPQ2d 1001, 1003-1004 (2006)]. The examiner has not present a convincing line of reasoning as to why a person having ordinary skill in the art would combine the teaching of Putzig (esterification or transesterification process using a titanium-based catalyst which is soluble in ethylene glycol) with the teaching of Sublett (**transesterification** process using a titanium-based catalyst which is soluble in ethylene glycol) to find obvious the claimed invention of an **esterification** process using a titanium-based catalyst which is not soluble in ethylene glycol.

Every limitation in the claims must be given effect rather than considering one in isolation from the others [In re Geerdes, 491 F2d 1260, 180 USPQ 789(CCPA 1974)]. The patentable difference of the present invention over the references is that the esterification process uses a catalyst complex comprising a **polymeric** titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_n]_n$  wherein n is up to 200. As noted above, neither Putzig, Sublett nor Braune disclose a polymeric titanium glycolate.

Claim 4 has been amended and now reads in part “wherein the total content of the metals of the catalyst is from 1 to 70 ppm based on the esterification component”. The phrase “wherein the molar ratio of the polymeric titanium glycolate and the alkali metal glycolate is 1.25:1 to 100:1” has been deleted. Support for the new language is found on page 3, lines 18-20, and in Claim 22, now canceled. This change in language has been made to Claim 4 to clarify the claimed subject matter.

The examiner argues that Claim 22 is rejected based on Sublett at col. 7, line 68, which discloses a ratio of metal/titanium metal ratio of 15 to 110 ppm and a formula to calculate the content of the metal in the catalyst. The citation is reproduced below:

Examples 8 through 19 show poly(ethylene terephthalate) prepared using the same titanium level but the ratio of the metal/titanium in the titanium metal complex ranges from 15 to 100 ppm sodium as analyzed in the polymer and is prepared with three different sodium sources, sodium carbonate, sodium bicarbonate, and sodium acetate.

(col. 7, line 65, to col. 8, line 3)

A concentration of **sodium** is disclosed (15 to 100 ppm). The formula to calculate the content of the metal of the catalyst is disclosed at col. 5, lines 45-68. The concentrations of sodium, titanium, manganese, cobalt, antimony and phosphorus in the Examples are disclosed in Table 1. The ranges for the metal titanium complex catalyst are shown below:

Na	Ti	Mn	Co	Sb	P	Total metal
15-100	18-21	54-61	44-84	207-232	29-116	156-592

The discussion of the Examples (col.7, line 34, to col. 8, line 68) relate to a comparison of "head space aldehydes" for polymer prepared with the metal titanium complex catalyst versus a manganese-cobalt-antimony-phosphorus catalyst with and without titanium and sodium compounds. There was no disclosure of the effect of varying the metal content.



Even if a prima facie case of obviousness were established by the cited references, the unexpected results of the claimed invention would satisfy the requirements of patentability. Relevant portions of the table from page 8 of the present application are reproduced below:

Example	Catalyst ppm	Total metal content of catalyst	L*	a*	b*	Time for polycondensation	M <sub>n</sub> (g/mol)
1	300 ppm Sb <sub>2</sub> Ac <sub>3</sub>	300 ppm	81.1	-1.9	-0.8	1h 39in	23200
2	300 ppm Ti-glycolate	300 ppm	78.4	-1.3	8.7	1h 38 min	23,100
5	20 ppm Sb <sub>2</sub> Ac <sub>3</sub>	20 ppm	81.7	-1.7	-0.2	3h 30 min	20,600
6	20 ppm Ti-glycolate	20 ppm	83.9	-2.1	2.2	2h 26 min	24,000
8	40 ppm Ti-glycolate 30 ppm Na-glycolate	70 ppm	83.7	-2.2	<b>1.2</b>	<b>1h 22 min</b>	23,500
9	30 ppm Ti-glycolate 20 ppm Na-glycolate	50 ppm	82.6	-2.6	<b>1.0</b>	<b>1h 27 min</b>	24,400
10	20 ppm Ti-glycolate 10 ppm Na-glycolate	30 ppm	85.3	-2.3	<b>0.9</b>	<b>1h 34min</b>	24,000

This data demonstrates the effectiveness on the important yellow-blue factor (b\*) and on time for polycondensation of the catalyst complex of i) a polymeric titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_4]_n$  wherein n is up to 200; and ii) an alkali metal glycolate, wherein the total content of the metals of the catalyst is from 1 to 70 ppm based on the esterification component compared to a commercial antimony-containing catalyst and a titanium glycolate catalyst (uncomplexed). The polymer from the Ti/Na glycolate

complex catalyst shows significant reduction toward neutral for the yellow-blue factor (b\*) compared to that for a titanium glycolate uncomplexed catalyst and reduced polycondensation time compared to that for a titanium glycolate uncomplexed catalyst or a commercial antimony-containing catalyst.

Further relevant portion of the table from page 8 of the present application are reproduced below:

Example	Catalyst ppm	Total metal content of catalyst	L*	a*	b*	Time for polycondensation	M <sub>n</sub> (g/mol)
3	300 ppm Ti-glycolate 150 ppm Na-glycolate	450 ppm	81.0	-1.6	4.3	1h 56 min	23,900
4	409 ppm Ti-glycolate 40.9 ppm Na-glycolate	449.9 ppm	80.5	-1.1	3.2	1h 24 min	24,100
7	50 ppm Ti-glycolate 40 ppm Na-glycolate	90 ppm	83.1	-2.8	4.0	1h 25 min	24,200
8	40 ppm Ti-glycolate 30 ppm Na-glycolate	70 ppm	83.7	-2.2	1.2	1h 22 min	23,500
9	30 ppm Ti-glycolate 20 ppm Na-glycolate	50 ppm	82.6	-2.6	1.0	1h 27 min	24,400
10	20 ppm Ti-glycolate 10 ppm Na-glycolate	30 ppm	85.3	-2.3	0.9	1h 34min	24,000

This data demonstrates the effectiveness on the important yellow-blue factor ( $b^*$ ) of the catalyst complex of i) a polymeric titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_4]_n$  wherein  $n$  is up to 200; and ii) an alkali metal glycolate, wherein the total content of the metals of the catalyst is from 1 to 70 ppm based on the esterification component compared to catalyst complex of i) a polymeric titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_4]_n$  wherein  $n$  is up to 200; and ii) an alkali metal glycolate, wherein the total content of the metals of the catalyst is over 70 ppm. The polymer from the Ti/Na glycolate complex catalyst with the total content of the metals of the catalyst from 1 to 70 ppm shows significant reduction toward neutral for the yellow-blue factor ( $b^*$ ) compared to that from a Ti/Na glycolate complex catalyst with the total content of the metals of the catalyst over 70 ppm.

Claim 26 has been added with the same claim language as Claim 4 except for use of the "consisting essentially of" transition phrase. Putzig discloses a catalyst composition of an organic titanium compound, a phosphorus compound, a tertiary amine, a solvent and, optionally, a cocatalyst (col. 1, line 61, to col. 2, line 5). Sublett discloses a catalyst system of manganese, zinc or calcium salts, cobalt salts, an antimony compound, a phosphorus compound and a complex of titanium alkoxides with an alkali or alkaline earth metal salt (col. 3, lines 40-51). Claim 26 claims a catalyst complex consisting essentially of i) a polymeric titanium glycolate represented by the formula  $[\text{TiO}_4(\text{CH}_2)_4]_n$  wherein  $n$  is up to 200; and ii) an alkali metal glycolate and does not contain a phosphorus compound, a tertiary amine, a cocatalyst, manganese, zinc or calcium salts, cobalt salts or an antimony compound.

### SUMMARY

In summary, the examiner is in error that Putzig discloses a process for the esterification with a catalyst comprising an organic titanium compound of two or more of a general formula  $[Ti(OR)_4]_n$  with n being 2 or more. The examiner is also in error that Sublett discloses a process for esterification. The combination of Putzig, Sublett and Braune does not make the claimed invention obvious to a person having ordinary skill in the art. The catalyst of the claimed invention is not the catalyst since the polymeric titanium glycolate is not soluble in ethylene glycol as are the catalysts of Putzig and Sublett. The claimed invention is for a process of esterification, which is not disclosed, taught or suggested by Sublett. Braune does not relate to a titanium catalyst for esterification. Even if the claimed invention were made obviousness by a combination of Putzig, Sublett and Braune, the unexpected results (yellow-blue factor and time or polycondensation) related to the total content of the metals of the catalyst being from 1 to 70 ppm would make the claimed invention patentable.

A Petition and Fee for Extension of Time under 37 CFR §1.136(a) is being filed concurrently with this paper. The Commissioner is hereby authorized to charge fees due by filing this paper or to credit any overpayment to Account No. 502025.

Respectfully submitted,



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